Expansion of multilayer target heated by short pulse with large penetration depth

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Problem of heating of a multilayer structure by hard x-ray laser is considered. Particular structure studied is made up from alternating metallic films m1–m2–m1–m2–..., each of 50 nm thick, deposited onto a thick Si or SiO_2 substrate; here m1 and m2 are metal one and metal two. It is supposed that an attenuation depth $d_{\rm att}$ in m1 amd m2 metals for the x-ray laser frequency is much larger than total thickness of the multilayer x-sandwich. In the substrate the attenuation depth is order of magnitude larger than in metals. Duration of pulse is short, much shorter than electron–ion temperature relaxation. An electron–ion temperature relaxation coefficient α (called coupling parameter) is different for metals m1 and m2. Thermal conduction coefficients κ are approximately the same $\kappa_1 \sim \kappa_2$ for both metals. The depth $d_{\rm att}$ is shorter for metal m2 where the coupling parameter is weaker. We consider a two-temperature stage where energy is absorbed mostly in m2; during and after absorption, the energy is conducted thermally to m1 where coupling is stronger. In this situation ion subsystem in m1 is heated faster than in m2. We compare pressure rise and beginning of expansion of the system.

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